au PG 06/87600

D1

PATENT SPECIFICATION

(11) 1 424 704

1 424 704

(21) Application No. 19974/73 (22) Filed 26 April 1973
(31) Convention Application No. 7 214 986
(32) Filed 27 April 1972
(31) Convention Application No. 7 314 898
(32) Filed 25 April 1973 in
(33) France (FR)
(44) Complete Specification published 11 Feb. 1976
(51) INT CL² F16H 41/32//F16D 33/14, 33/16
(52) Index at acceptance
F2W 042 10B1 112 114 118 120 126 16A1 18 20X1 264 301 326 340

(19) THE PATENT OFFICE LONDON

(54) HYDRAULIC COUPLING DEVICE

(71) We, SOCIETE ANONYME FRANCAISE DU FERODO, a French Body Corporate, of 64 Avenue de la Grande Armée, 75017-Paris, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates generally to hydraulic couplings of the kind usually comprising two bladed wheels connected respectively to a driving shaft and to a driven shaft, these wheels being disposed opposite one another in such a manner as to form between them a working circuit for the working fluid.

For the purpose of cooling hydraulic coupling devices of this kind, particularly those of the constant filling type, it is known to equip them externally with ventilation fins, but this arrangement is not always found sufficient.

Furthermore, variable filling couplings are known which are equipped with bleeding means, which generally comprise a scoop dipping into a chamber outside the working circuit and in communication with the latter. This scoop is longitudinally adjustable in position in order to permit a modification of the amount of working fluid present in the coupling, and consequently a modification of the operating characteristics of the coupling device.

It has already been proposed to provide constant filling couplings with a scoop of this kind normally used for variable filling in order to circulate the working fluid in the coupling through an external heat exchanger.

It will however readily be understood that solely from the point of view of the desired cooling of the working fluid, this arrangement is cumbersome and expensive.

The object of the present invention is a hydraulic coupling equipped with means which permit the cooling of the working fluid in a simple and economic manner.

According to the present invention, there is provided a hydraulic coupling comprising a bladed impeller wheel mounted on and rotatable with a driving shaft, and a bladed turbine wheel mounted on and rotatable with a driven shaft, said bladed wheels being disposed opposite each other and forming together a working circuit for working fluid in the coupling, and at least one bleed tube for bleeding working fluid from the working circuit received at its radially inner end in a radial bore in said driven shaft and fixed for rotation therewith, said bleed tube communicating with an enclosure outside the working circuit and penetrating into and extending across the working circuit so that the free, radially outer end of the bleed tube is in close proximity to the periphery of said bladed turbine wheel remote from said driven shaft.

The enclosure advantageously comprises heat exchange means outside the device.

Preferably the bleed tube is disposed in a radial plane passing through the axis of the coupling, and the free outer end of the bleed tube is suitably bevelled.

In all cases, since the bleed tube is immersed directly in the working circuit, the tube is adapted to receive the working fluid directly and thus to direct it towards the heat exchanger, although a pump may be provided in cases where it is necessary to cool a considerable flow of working fluid, particularly during slight slip in the coupling.

The bleed tube, with which there may be associated a plurality of similar tubes regularly distributed circumferentially on the turbine side of the working circuit, is disposed actually inside the space formed by the bladed wheels of the device and therefore does not in any way increase the axial dimensions of the latter.

The flow of fluid taken off by the bleed tube increases with the meridian speed of this fluid in the working circuit, and therefore with slip.

This flow is therefore maximum during

starting, when the heat to be dissipated is high.

In proportion as slip decreases, that is to say in proportion as the angular speed of the receiving bladed wheel approaches that of the driving bladed wheel, the flow of fluid circulating in the bleed tube decreases until it becomes negligible or zero.

It is of course possible to provide hydraulic coupling devices of the kind described above with a rotating reservoir with which the working circuit is in communication through a calibrated passage and in which a filling tube is immersed, the filling tube being rotationally fixed and connected to the working circuit.

The centrifugal force, which is greater the higher the speed of the bladed wheels, and therefore the lower the slip when the rotational speed is close to normal operation, forces part of the working fluid contained in the working circuit to pass from the latter to the associated rotating reservoir, the filling tube immersed in the latter effecting the return of this working fluid to the working circuit.

Between the working circuit and the rotating reservoir, which may itself constitute heat exchange means capable of effecting the cooling of the working fluid, there is thus established a circulation of fluid which is greater, the higher the speed of the bladed wheels and therefore, since slip is then low, the lower the meridian speed of the working fluid in the working circuit.

The filling tube is in fact essentially intended to permit modification of the filling of the working circuit with working fluid, and therefore a modification of the operating characteristics of the entire system, and to this end such tubes are generally mounted so as to be longitudinally adjustable in position in order to be able to penetrate to a greater or lesser extent into the rotating reservoir with which they are associated.

Nevertheless, since the circulating flow decreases when slip increases, and therefore when the heat to be dissipated is higher, cooling is not effected under good conditions, particularly when slip is high.

In a variant, in order to obtain better operation, means are provided to ensure that the flow of circulating fluid of the working circuit towards heat exchange means outside the circuit will be practically constant whatever the speed of the bladed wheels, that is to say whatever the degree of slip between these wheels.

More particularly, in this variant the chamber to which the bleed tube is connected is a rotating reservoir with which the working circuit is also in communication through a calibrated passage and in which is immersed at least one filling tube, the said filling tube being rotationally fixed and connected to the working circuit. On starting, and with heavy slip, the bleed tube provides the essential part of the flow of working fluid directed towards heat exchange means outside the working circuit, which heat exchange means may be constituted solely by the rotating reservoir associated with the device.

When slip is low, the essential part of the flow of fluid directed towards these heat exchange means is provided by the calibrated passage associated with the working circuit.

In all cases the filling tube effects the return of this fluid to the working circuit.

Thus the combination of a bleed tube, a calibrated passage, and a filling tube ensures that these elements will co-operate in maintaining the flow of working fluid allowed to pass into heat exchange means outside the working circuit, while this flow can thus advantageously be substantially constant whatever the slip.

Furthermore, for the purpose of using a hydraulic coupling as a speed variator, it is customary to use a rotating reservoir inwhich is immersed an emptying scoop which controls the level of working fluid in the rotating reservoir and consequently in the working circuit, and which is adapted to supply to a fixed reservoir an amount of working fluid dependent on its position.

By longitudinal adjustment of this scoop it is thus possible to control the amount of working fluid remaining in the working circuit and consequently to modify the speed ratio between the driving shaft and the driven shaft.

For the purpose of returning working fluid from the fixed reservoir to the working circuit when required, after passing it if necessary through a heat exchanger for cooling purposes, it is necessary for a hydraulic coupling of this kind to be equipped with an auxiliary pump adapted to effect the corresponding circulation of fluid.

A hydraulic coupling of this kind has in particular the disadvantage of being long in the axial direction, because of its rotating reservoir, and expensive because of the said reservoir and of the auxiliary pump.

According to another variant of the invention, means are provided for making the hydraulic coupling suitable for working as a speed variator without having these disadvantages.

More particularly, according to this variant, the coupling comprises a working fluid reservoir which is rotationally fixed and which is connected to the working circuit on the one hand by the bleed tube which is immersed in the latter near its periphery and on the other hand by a return

pipe, means being provided to permit adjustment of the level of the said reservoir and therefore of the filling of the coupling.

In a hydraulic coupling of this kind advantageous use is made of the circulation of fluid which is established in the working circuit, or more precisely of the high meridian speed of this fluid in the proximity of the periphery of the working circuit, particularly when relatively considerable slip exists between the wheel connected to the driven shaft and the wheel connected to the driving shaft, this circulation of fluid in the working circuit most usually being found sufficient to provide a natural circulation of the fluid in the bleed tube, and thus to branch off a determined amount of the said fluid towards the fixed reservoir.

Nevertheless, according to a development of the invention which is particularly applicable when a hydraulic coupling of this kind must also function with relatively slight slip between the wheel connected to the driving shaft and the wheel connected to the driven shaft, provision is made for the insertion in the pipe or connection made between the bleed tube and the fluid reservoir of a pump adapted to accelerate the circulation of fluid therein, if necessary.

In all cases the circulation of fluid is obtained with the aid of particularly simple and therefore economical means.

Furthermore, for the modification of its level, the fluid reservoir may contain an overflow pipe which is in communication with the working circuit of the device and which is movable in relation to the reservoir, in which case the latter is fixed.

In all cases, a modification of the level of this reservoir simultaneously provides a parallel modification of the amount of fluid remaining in the working circuit.

An arrangement of this kind has the advantageous consequence that the hydraulic coupling used is small in size and relatively low in cost.

The characteristics and advantages of the invention will moreover be clear from the following description which is given by way of example and with reference to the accompanying diagrammatical drawings, in which:

Figure 1 is an axial sectional view of a hydraulic coupling according to the invention;

Figure 2 is a simplified view in axial section of this coupling on a smaller scale, illustrating the arrangement of the heat exchange elements;

Figure 3 is a similar view to Figure 2 and relates to a modified embodiment;

Figure 4 is a view similar to Figure 1 but relates to another embodiment of coupling;

Figure 5 is a diagram illustrating the operation of the embodiment shown in Figure 4:

Figure 6 relates to another embodiment of coupling.

Reference will first be made to Figure 1, in which a hydraulic coupling is shown comprising a first bladed wheel 10, hereinafter referred to as the driving wheel or pump, and which on the outside forms a first half-casing; the latter is peripherally fixed to a second half-casing 11 adapted to be rotationally fixed at 12 to a driving shaft (not shown).

These two half-casings together form an internal space in which there are disposed, in addition to the substantially radial blades fastened to the driving wheel 10, blades 14 carried substantially radially by a second bladed wheel 15, hereinafter referred to as the receiving wheel or turbine, which is rotationally fixed on a driven shaft 16 which in the embodiment illustrated passes axially through the entire coupling.

Between this driven shaft 16 and the two half-casings 11 there are interposed in the usual manner bearings 17, 18 and seals 19, 20.

Deflectors 22, 23 are associated, likewise in the usual manner, with the bladed wheels 10, 15 in the proximity of the driven shaft 16, and the blades 13, 14 carried by these wheels are disposed opposite one another in a peripheral portion 25 of the internal space formed by the said wheels, this portion usually being called the working circuit.

According to the invention, at least one bleed tube 26 is provided inside the space in question, and this bleed tube is carried by the driven shaft 16. In practice, a plurality of such tubes may be provided, for example three, and these tubes are then regularly distributed circumferentially; in order to simplify the present explanation, only one of these tubes will be described below.

This bleed tube 26 extends entirely in a plane passing through the axis of the coupling.

More precisely, it extends from a fastening end 27 which is relatively close to the axis of the and by which it is engaged in a radial passage 28 provided in the driven shaft 16, and by which it is therefore rotationally fixed to the latter, to a free end 29 which is relatively close to the periphery of the coupling and by which it penetrates into the working circuit 25 in the portion of the latter which is formed by the receiving wheel 15, between two blades 14 of the latter.

For preference, as illustrated, this free end 29 is bevelled.

Likewise for preference, this free end 29 is disposed near the end wall 30 of the bladed wheel 15, so that, as will be seen herein-

below, entry of the working fluid into the tube 26 is assisted, taking into account the circulation of the said fluid in the working circuit 25 as shown by the arrows 31.

In the embodiment illustrated the driven shaft 16 is hollow; it is pierced axially by a passage 32.

At one end of this passage is engaged a splined shaft 33, and at the other end a fixed hub 34.

Together with the driven shaft 16 the said hub forms inside the lattter a first chamber 35 which is in communication with the radial passage 28 of the driven shaft 16 in which the bleed tube 26 is engaged.

This chamber 35 is formed at the end of the hub 34 and is isolated by a closure plate 36 from the portion of the bore 32 in which the splined shaft 33 is engaged; this splined shaft 33 forms the actual driven shaft.

Together with the driven shaft 16, the fixed hub 34 also forms a second chamber 37 inside the said shaft.

This second chamber 37 is formed annularly around the hub 34 and is in communication with the inside space of the coupling through passages 38 provided radially in the driven shaft 16.

The two internal chambers 35, 37 are separated from one another by a seal 39.

Bearings 40 are in addition interposed between the fixed hub 34 and the driven shaft 16, together with another seal 41.

The fixed hub 34 is pierced axially by at least one longitudinal passage 42 which is in communication with the inner chamber 35, and by at least one longitudinal passage 43 which communicates through a radial passage 44 with the second inside chamber 37.

A heat exchanger 50 is associated in the usual manner with a hydraulic coupling of this kind (Figure 2).

An inlet end of the said heat exchanger is connected by a pipe 51 to the longitudinal passage 42 in the fixed hub 34, while its outlet end is connected by a pipe 52 to the longitudinal passage 43 of the fixed hub 34.

During operation the working fluid contained in the working circuit 25 penetrates into the bleed tube 26 because of its circulation in the direction of the arrows 31 and is directed by the said tube through the inner chamber 35, the longitudinal passage 42 in the fixed hub 34, and the pipe 51 to the heat exchanger 50.

After cooling in the latter this working fluid returns to the coupling through the pipe 52, the passages 43 and 44 in the fixed hub 34, the inner chamber 37, and the radial passage 38 of the driven shaft 16.

If necessary, particularly for slight slip, a pump 55 may be provided on the pipe 51, as illustrated in Figure 2.

In the embodiment illustrated in Figure 2, the heat exchanger 50 is disposed below the axis of the apparatus.

As an alternative, it is disposed above this axis in Figure 3.

In this case a non-return valve 60 is advantageously disposed in the pipe 51 in order to prevent the emptying of the heat exchanger 50 to the actual coupling during a stoppage, since this emptying could modify the filling of the coupling and therefore its working characteristics.

Furthermore, Figure 3 illustrates another modified embodiment. In this embodiment, which may be adopted with any of the general arrangements illustrated in Figures 2 and 3, the fixed hub 34 associated with the driven shaft 32 for the connection of the bleed tube 26 to the outside is disposed around the driven shaft and axially extended pipes are provided in this driven shaft for the purpose of making this connection, in co-operation with passages provided in the said hub.

Reference will now be made to Figures 4 and 5. The hydraulic coupling shown in Figure 4 comprises a first bladed wheel 110, hereinafter referred to as the driving wheel or pump; this wheel is fixed peripherally to a casing 111 adapted to be rotationally fixed to a driving shaft (not shown).

The driving wheel 110 is provided internally with substantially radial blades 113.

A second bladed wheel 114, hereinafter referred to as the receiving wheel or turbine, is disposed in the casing 111 in a position opposite the bladed wheel 110; the wheel 114 carries radially blades 115 which are located opposite the blades 113 of the driving wheel 110, and it is rotationally fixed on a driven shaft 116, about which the driving wheel 110 extends, with the interposition of a bearing 117.

The driving wheel 110 and the receiving wheel 114 together form a space 118 known as the working circuit.

Outside the working circuit 118 the casing 111 forms together with the driving wheel 110 a rotating reservoir 119 located on the opposite side of the said wheel to that where the receiving wheel 114 is located.

Like the driving wheel 110, the rotating reservoir 119 extends around the driven shaft 116, and in this rotating reservoir 119 is accommodated a filling tube 120 carried by a fixed sleeve 121, which is separated from the driven shaft 116 by a bearing 122 and from the casing 111 by a rotating seal 123.

In practice a spacer sleeve 124 extends axially between the bearings 117 and 122 between the driven shaft 116 and the fixed sleeve 121.

The filling tube 120 extends substantially radially from a blind end 125 to an open end 126 and the latter is relatively close to the periphery of the casing 110.

Through a port 127 the inner passage of this filling tube communicates with a channel 128 formed in the fixed sleeve 121 in a direction substantially parallel to the axis of the whole arrangement.

With this first channel 128 is associated a second channel 129, which is likewise located substantially parallel to the axis of the entire arrangement, in the fixed sleeve 121, this channel 129 leading into annular groove 130 formed at the end of the fixed sleeve 121 opposite the driving wheel 110.

The chamber formed by this annular groove 130 is in communication with axial passages 132 provided in the driving wheel 110, which thus permit communication between this chamber and the working circuit 118.

In practice the channels 128 and 129 of the fixed sleeve 121 are disposed one on each side of the axial plane of the said sleeve, constituting the plane of Figure 4.

It is for this reason that in this Figure the channel 128 is shown in broken lines and the channel 129 is dot-and-dash lnes.

These channels 128 and 129 lead to the outside of the rotating vessel 119. where they may be connected either directly to one another by a connecting flange of any kind (not shown), or may be connected to one another by way of a heat exchanger outside the whole arrangement.

In a manner known *per se* the filling tube 20 is mounted for longitudinal adjustment in position on the fixed sleeve 121 under the control of an operating device comprising a lever 135, which is connected to the filling tube 120 and rotationally fixed on a shaft 136, and an operating lever 137 which is fixed on the said shaft 136 outside the rotating reservoir 119.

Near the periphery of the working circuit 118 the casing 111 has a calibrated passage 141 which, in an arrangement which is known *per se,* establishes communication between the working circuit 118 and the rotating reservoir 119.

The driven shaft 116 has an axial channel 143 and carries radially a bleed tube 144 which extends entirely in a plane passing through the axis of the device, in the portion of the working circuit 118 formed by the receiving wheel 114, from one end 145, by which it is engaged in a radial passage 146 in the driven shaft 116, to a free end 147 relatively close to the periphery of the working circuit 118.

The radial passage 146 of the driven shaft 116, in which the bleed tube 144 is engaged, communicates with the axial channel 143 in the said shaft 116.

The driven shaft 116 is in addition provided with radial passages 148 which establish communication between its axial channel 143 and the space contained between the driven shaft 116 and the spacer sleeve 124; the latter in turn has radial passages 150 opposite the aforesaid radial passages, and the fixed sleeve 121 is in turn pierced with radial passages 152 in line with radial passages 150 in the spacer sleeve 124.

On starting up, or under operating conditions in which the relative slip between the wheels 110 and 114 is high, the meridian speed of the working fluid in the working circuit 118 is in turn high, and, since this working fluid circulates in the direction shown by the arrows 160 in Figure 4, part of this working fluid is naturally introduced into the bleed tube 144 and through the latter into the passage 146, the axial channel 143 and the passages 148 of the driven shaft 116, the passages 150 of the spacer sleeve 124, and the passages 152 of the fixed sleeve 121, so that the fluid taken up by the tube 144 reaches the rotating reservoir 119.

This fluid is received by the filling tube 120 and by way of the channels 128 and 129 in the fixed sleeve 121 and the axial passages 132 in the driving wheel 110 it returns to the working circuit 118.

The rotating reservoir 119 may itself constitute a heat exchange means adapted to effect the cooling of the fluid reaching it.

However, as explained above, this cooling may be increased or supplemented by connecting the channels 128 and 129 to an external heat exchanger, in which case the working fluid circulates in thi heat exchanger before returning to the working circuit 118.

As already stated above, the flow of working fluid taken by the bleed tube 144 is high on starting up or when there is considerable slip between the wheels 110 and 114.

On the other hand, when the relative slip is slight, the meridian speed of the working fluid in the working circuit 118 is low, and the same applies to the flow of liquid taken from this working circuit by the bleed tube 144.

When slip decreases, an increasing flow of fluid passes through the calibrated passage 141 of the working circuit 118 to the rotating reservoir 119, while the filling tube 120 effects the return of this fluid to the working circuit 118.

Thus, due to the combined action of the bleed tube 144 and of the calibrated passage 141, the flow of fluid allowed to reach the rotating reservoir 119 is substantially constant whatever the speed of rotation of the wheels 110,114, and therefore whatever the slip.

This result is illustrated by the diagram in Figure 5, which shows on the abscissa the slip G and on the ordinate the flow D leaving the working circuit 118 towards the

rotating reservoir 119.

The curve D_2 corresponds to the part of this flow which is effected by the bleed tube 144, and the curve D_1 shows the part of this flow effected by the calibrated passage 141.

The curve D_3 represents the total of the flows D_1, D_2; in practice it is a substantially horizontal straight line.

Reference will now be made to Figure 6, in which a hydraulic coupling comprises a first bladed wheel 210 hereinafter referred to as the driving wheel or pump, which forms on the outside a first half-casing; the latter is fastened peripherally to a second half-casing 211 adapted to be rotationally fixed to a driving shaft (not shown).

These two half-casings together form an internal space in which there are disposed, in addition to substantially radial blades 213 fastened to the driving wheel 210, blades 214 which are carried substantially radially by a second bladed wheel 215, which will hereinafter be referred to as the receiving wheel or turbine and which is rotationally fastened on a driven shaft 216 which, in the embodiment illustrated, passes axially from one side to the other of the device.

Bearings 217, 218 are interposed respectively between the half-casings 210, 211 and the driven shaft 216.

Furthermore, a seal 219 is interposed between the half-casing 211 and the said driven shaft 216.

A reservoir 220, which is rotationally fixed, is associated with this hydraulic coupling device.

In the embodiment illustrated in Figure 6, this reservoir 220 is carried by a fixed flange 221 which annularly surrounds the driven shaft 216 with the interposition of a bearing 222; two seals 223 and 224 are provided one on each side of the latter, the first seal being disposed between the flange 221 and the casing 210 and the second between the flange 221 and the driven 216.

Two connections are made between this non-rotating reservoir 220 and the working circuit 226 formed by the co-operation of the driving wheel 210 and the receiving wheel 215, namely a bleed connection and a return connection.

The bleed connection comprises a bleed tube 227 which penetrates into the working circuit 226 near the periphery of the latter.

This bleed tube 227 is preferably rotationally connected to the driven shaft 216, as illustrated, and extends in the portion of the working circuit formed by the bladed wheel 215 fastened to the said shaft, from a fastening end 228, by which it is engaged in a radial passage 229 in the driven shaft 216, to a free end 230 situated in the immediate proximity of the periphery of the working circuit 226.

Between its fastening end 228 and its free end 230 the running portion of the bleed tube 227 preferably follows, as illustrated, the contour of the receiving bladed wheel 215 between two blades 214 on the latter.

The bleed tube 227 thus extends substantially in a axial plane of the coupling.

Furthermore, the driven shaft 216 is pierced parallel to its axis, and preferably coaxially to the latter, by an internal channel 232 which is in communication with the radial passage 229 in which the bleed tube 227 is engaged.

This channel 232 in the driven shaft 216 is likewise in communication with the reservoir 220 through in succession, in the example illustrated, a passage 233 disposed substantially radially in the driven shaft 216, the rotor 234 of a centrifugal pump 235, and a tube 237 which projects vertically from the bottom of the reservoir 220.

The rotor 234 of the pump 235 is fastened on the driven shaft 216 and is mounted for rotation in a toric chamber 238 provided in the flange 221, between the seals 223 and 224, or more precisely between the seal 223 and the bearing 222.

The tube 237 passes through this toric chamber 238 and is in communication with an outlet channel 239 of the latter, this channel preferably extending tangentially to the said chamber (not visible in Figure 6).

The return connection provided between the reservoir 220 and the working circuit 226 comprises a tube 240 projecting from the bottom of the said reservoir and in communication with an annular chamber 241 established around the driven shaft 216 between the seal 223 and the toric chamber 238 and therefore between the seals 223 and 224.

This chamber 241 is in communication with the working circuit 226 through passages 242 disposed obliquely in the driving wheel 210.

Means are provided for controlling the level 245 of fluid in the reservoir 220.

In the example illustrated in Figure 6, the reservoir 220 is fixed and these level adjustment means comprise an overflow pipe composed of two lengths of piping engaged telescopically in one another.

The first of these lengths of piping, that is to say the lower pipe, is constituted by the pipe 240 which is connected to the reservoir 220 and by which the latter is in communication with the working circuit 226, while the second length of piping, the upper pipe, is an overflow pipe 248 mounted for longitudinal movement in the pipe 240.

This overflow pipe 248 has an aperture 249 and is connected to control means, for example a fork 250 mounted pivotally at a fixed point 251 and articulated at 252 on the pipe 248.

As can easily be understood, the quantity

of fluid allowed to enter the working circuit 226 depends on the height of the level 245 of this fluid in the reservoir 220, and therefore on the position of the overflow pipe 248 in this reservoir.

During operation the working fluid contained in the working circuit circulates from the driving wheel 210 to the receiving wheel 215 at the periphery of the working circuit 226, and from the receiving wheel 215 to the driving wheel 210 in the portion of this working circuit close to the axis; this circulation is diagrammatically indicated by the arrows F in the Figure.

Consequently, part of this fluid is obviously received in the bleed tube 227 and from the latter reaches the reservoir 220.

The level of fluid in the reservoir therefore rises and the pipe 248, serving as overflow, continuously returns to the working circuit part of the fluid which was previously taken out of the latter.

When slip is considerable, particularly during starting up, this natural circulation may be sufficient; for lower slip it is advantageously accelerated by the centrifugal pump 235.

In all cases, action on the fork 250 makes it possible to raise or lower the fluid level 245 in the reservoir 220, and therefore to decrease or increase the amount of fluid contained in the working circuit 226, and consequently to modify the speed ratio between the driving and driven shafts.

In a modified embodiment (not shown) it is possible to provide two pipes having angled inlets rotating in relation to one another.

Furthermore, in all cases this reservoir 220 may advantageously itself constitute heat exchange means or else be associated with heat exchange means for the purpose of cooling the working fluid.

WHAT WE CLAIM IS:—

1. A hydraulic coupling comprising a bladed impeller wheel mounted on and rotatable with a driving shaft, and a bladed turbine wheel mounted on and rotatable with a driven shaft, said bladed wheels being disposed opposite each other and forming together a working circuit for working fluid in the coupling, and at least one bleed tube for bleeding working fluid from the working circuit received at its radially inner end in a radial bore in said driven shaft and fixed for rotation therewith, said bleed tube communicating with an enclosure outside the working circuit and penetrating into and extending across the working circuit so that the free, radially outer end of the bleed tube is in close proximity to the periphery of said bladed turbine wheel remote from said driven shaft.

2. A hydraulic coupling according to Claim 1, wherein the bleed tube is disposed entirely in a radial plane passing through the axis of the coupling.

3. A hydraulic coupling according to Claim 1 or Claim 2, wherein the said enclosure constitutes heat exchange means.

4. A hydraulic coupling according to any of the preceding claims, wherein the free outer end of the bleed tube is bevelled.

5. A hydraulic coupling according to any of the preceding claims, wherein the driven shaft is hollow and mounted on a fixed hub, and the bleed tube is in communication with a first chamber, at least one longitudinal passage through the hub for establishing communication between an inlet of the enclosure and the first chamber, at least one longitudinal passage adapted to establish communication between an outlet of the said enclosure and a second chamber also in the driven shaft communicating with the working circuit.

6. A hydraulic coupling according to Claim 5, wherein the first chamber is formed at the end of the hub, the second chamber is formed annularly around the hub, and the said chambers are separated from each other by a seal.

7. A hydraulic coupling according to any one of Claims 1 to 4, wherein the driven shaft is mounted on a fixed hub, and axially extending pipes are provided in the driven shaft in co-operation with passages provided in the said hub for connecting the bleed tube to the said enclosure.

8. A hydraulic coupling according to any one of the preceding Claims, wherein a pump is provided between the bleed tube and the said enclosure.

9. A hydraulic coupling according to any one of Claims 3 to 8, wherein a non-return valve is interposed between the said enclosure and the bleed pipe when the heat exchange means is disposed above the axis of the coupling.

10. A hydraulic coupling according to any of the preceding Claims, wherein the said enclosure is connected to a rotating reservoir with which the working circuit is in communication through a calibrated passage and into which penetrates at least one filling tube, the said filling tube being rotationally fixed and being connected to the working circuit.

11. A hydraulic coupling according to Claim 10, wherein the rotating reservoir extends around the driven shaft, and the driven shaft has an axial channel which communicates with the said rotating reservoir through at least one substantially radial passage.

12. A hydraulic coupling according to Claim 11, wherein inside the rotating reservoir the driven shaft is surrounded by a fixed sleeve carrying the filling tube, the said sleeve having substantially radial passages

communicating with the said rotating reservoir.

13. A hydraulic coupling according to any one of Claims 10 to 12, wherein the filling tube communicates with the working circuit through heat exchange means located outside the reservoir.

14. A hydraulic coupling according to any one of Claims 10 to 13, wherein the filling tube is mounted for longitudinal adjustment in position in the rotating reservoir, under the control of a control device outside the reservoir.

15. A hydraulic coupling according to any of Claims 1 to 4, wherein the enclosure is a working fluid reservoir which is rotationally fixed and is connected to the working circuit through the said bleed tube and through the return pipe, means being provided to permit adjustment of the level of the said reservoir and therefore of the filling of the coupling.

16. A hydraulic coupling according to Claim 15, wherein the bleed tube is connectec to the said fluid reservoir through a pump.

17. A hydraulic coupling according to Claim 16, wherein the said pump has its rotor fixed to the driven shaft in line with at least one substantially radial passage in the driven shaft which communicates with a longitudinal channel in the drive shaft, the rotor being mounted for rotation in a fixed toric chamber with which the fluid reservoir is in communication.

18. A hydraulic coupling according to Claim 17, wherein the said fixed toric chamber communicates with the fluid reservoir through an outlet duct extending substantially tangentially in relation to the said toric chamber.

19. A hydraulic coupling according to any one of Claims 15 to 18, wherein an overflow pipe for adjusting the level of the fluid reservoir is provided and communicates with a working circuit, and wherein the reservoir and overflow pipe are mounted for movement relative to each other.

20. A hydraulic coupling according to Claim 19, wherein the reservoir is fixed and the said overflow pipe is formed by upper and lower lengths of piping engaged telescopically in one another, the lower length of piping being connected to the reservoir and communicating with the working circuit and the upper length of piping being mounted for longitudinal movement in relation to the lower length of piping.

21. A hydraulic coupling according to Claim 20, wherein the upper, ovable length of piping is connected to control means.

22. A hydraulic coupling according to any of the preceding Claims, wherein a plurality of bleed tubes are provided regularly distributed circumferentially on the turbine side of the working circuit.

23. Hydraulic coupling apparatus substantially as hereinbefore described with reference to Figures 1 and 2, or Figure 3 or Figures 4 and 5 or Figure 6 of the accompanying drawings.

PAGE, WHITE & FARRER,
Chartered Patent Agents,
27, Chancery Lane,
London, WC2A 1NT.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1976.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

FIG. 1

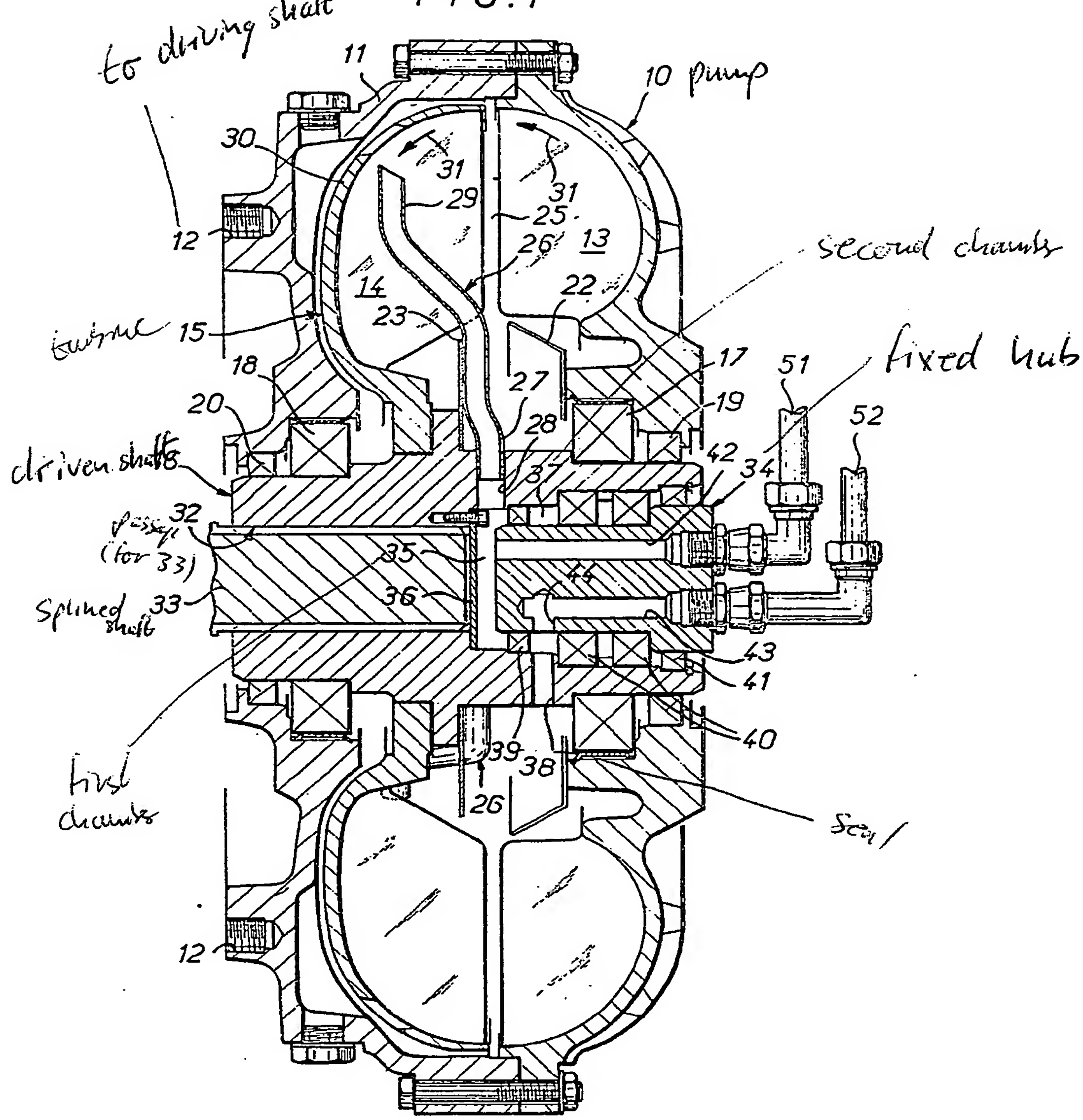

to driving shaft
11
10 pump
30
31
29
25
26
13
14
12
second chamber
22
turbine
15
23
18
27
17
51
fixed hub
20
28
19
52
driven shaft
42
34
37
32
passage (for 33)
35
44
splined shaft 33
36
43
41
40
39
38
first chamber
26
seal
12

FIG. 2

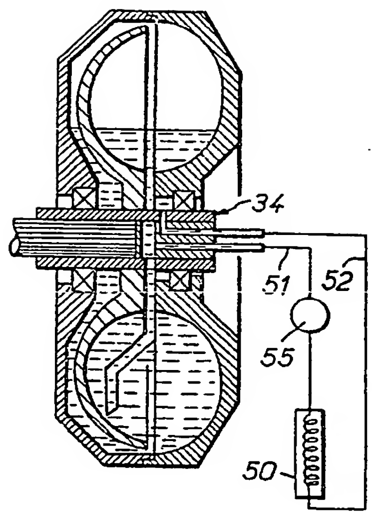


FIG. 3

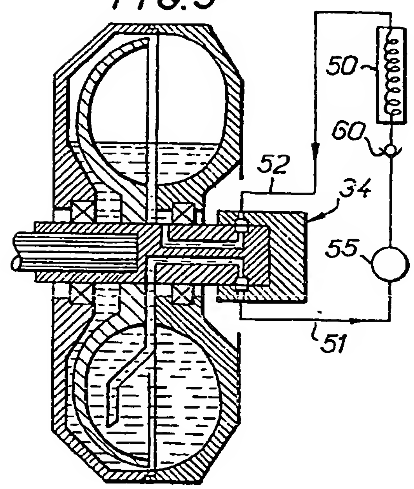


FIG. 5

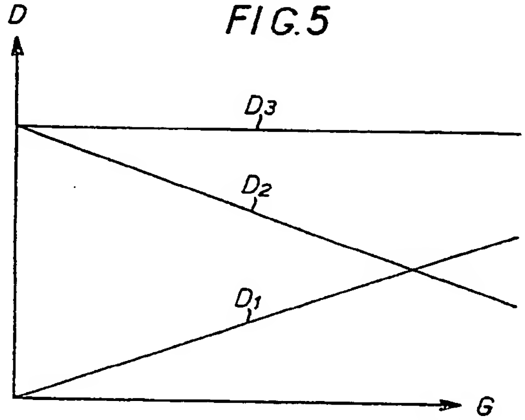


FIG. 4

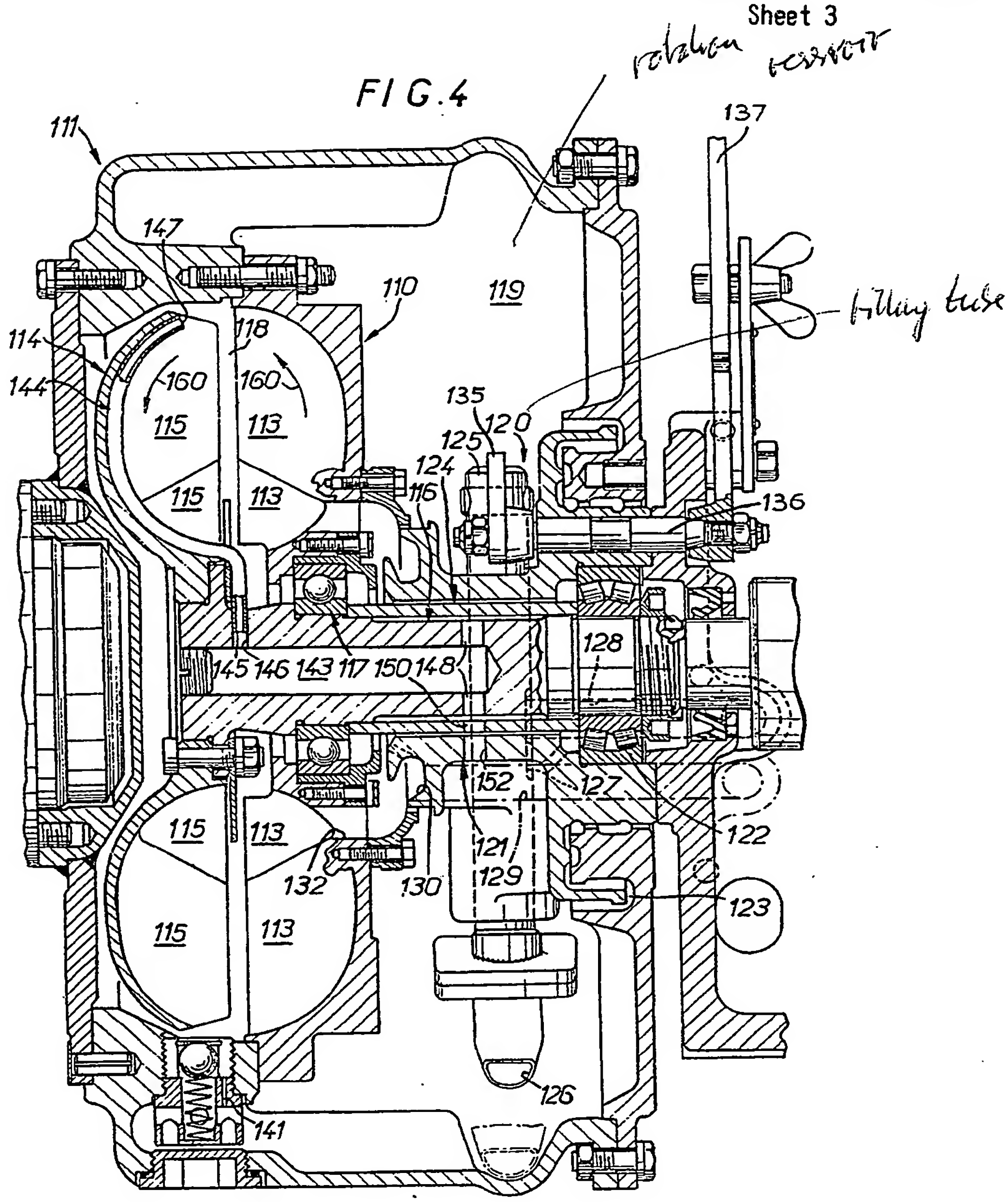
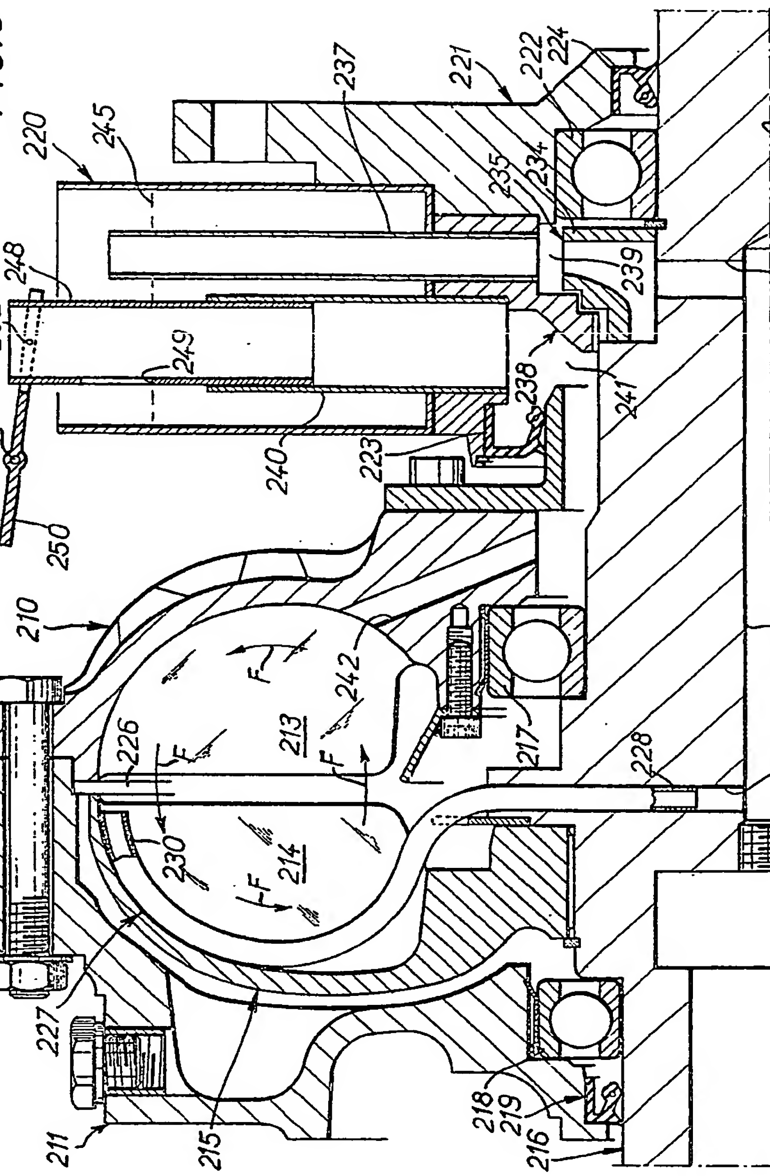

rotation reservoir
137
111
147
110
119
filling tube
118
114
160
160
144
115
113
135
120
125
124
115
113
116
136
145 146 143 117 150 148
128
152
127
122
115
113
121
129
132
130
123
115
113
126
141

FIG. 6


220
245
237
221
222
224
235
234
246
239
233
248
252
249
238
241
251
223
240
250
210
242
213
226
217
232
228
229
230
214
227
215
218
219
216
211
F